ELECTROSTATIC VIDEO DISPLAY DRIVE CIRCUITRY AND DISPLAYS INCORPORATING SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of Kalt patent application Ser. No. 09/055,575 filed Apr. 6, 1998, now U.S. Pat. No. 6,057,814. is a continuation-in-part of Kalt patent application Ser. No. 08/871,486 filed Jun. 9, 1997, now abandoned which is a continuation-in-part of Kalt patent application Ser. No. 08/681,606, now U.S. Pat. No. 5,638,084 dated Jun. 10, 1997 which, in turn, is a continuation of Kalt patent application Ser. No. 08/228,111 filed Apr. 15, 1994, now abandoned which in turn is a continuation-in-part of patent application Ser. No. 08/066,949 of Kalt, filed May 24, 1993, now U.S. Pat. No. 5,519,565, which in turn is a continuation-in-part of application Ser. No. 07/887,714 filed May 22, 1992, now U.S. Pat. No. 5,231,559. Continuation status is NOT claimed from application Ser. No. 08/871,486 and such other earlier filed application, at this time. The disclosures of U.S. Pat. Nos. 5,638,084, 5,519,565 and 5,231,559 are hereby incorporated herein by reference thereto. These three patents are referenced hereinbelow as "the parent patents".

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to electronically driven displays that can translate electrical signals into changeable static images or dynamic video images, and includes multicolor and full color displays. Such displays, or display screens, can comprise a pixellated screen formed by a multitude of individual, selectable state, light-modulating picture elements that can be controlled to provide text or graphic images. More particularly, the invention relates to electrostatic displays which employ capacitive pixels having light-modulating, movable electrodes that can adopt a number of positions, at least one of which is a position extending across the path of a light beam traveling through the pixel. By selective actuation of the movable electrode to interrupt the light beam to a greater or lesser extent, and to change the appearance of individual pixels, groups of such capacitive pixels in the display can be composed into meaningful images.

2. Description of Related Art Including Information Disclosed under 37 CFR 1.97 and 37 CFR 1.98

The above-mentioned parent patents describe, inter alia, a number of capacitively driven, or electrostatic, pixellated video display inventions including, as disclosed in U.S. Pat. No. 5,638,084, an indoor-outdoor multicolor display viewable by transmitted or reflected light. Each pixel of the display employs a movable electrode which, in preferred embodiments takes the form of a miniature metallized plastic coil or spiral while in a relaxed condition. Application of an electrical pulse between the coil and a fixed electrode located on the other side of a dielectric layer from the coiled movable electrode, (termed a "spiral rollout" herein), causes the coil to unfurl across the dielectric layer to modulate light rays striking the pixel, e.g. to block or reflect, them. In effect, the spiral rollout acts as a shutter for the pixel.

Such electrostatic, pixellated displays have advantages of low power consumption, low heat output, and low cost and in some embodiments, of being able to display brilliant reflective images that are viewable outdoors in daylight.

Furthermore, preferred embodiments of such electrostatically driven displays are susceptible to mass production from suitably treated low cost polymer film materials. U.S. Pat. No. 5,638,084 discloses a full color video display viewable indoors or outdoors, wherein a mosaicked color screen is aligned behind a black screen comprised by an array of electrostatic shutters each of which registers with a colored or white mosaic element in the color screen.

Suitable drive circuitry for such displays is known, for example, from U.S. Pat. No. 4,336,536 to Kalt and Babcock ("Kalt and Babcock" herein) which discloses drive circuitry for a pixel display panel which permits selective pixel actuation in rapidly changing, desired groups and patterns of spiral rollouts. Disclosed is a half select row and column drive system, operating in response to timing information extracted by a sync circuit, video information from an incoming signal is supplied to a shift register for loading into columns coupled to the fixed electrodes of the pixels, while row synchronization of the movable electrodes is maintained by a ring counter operating in combination with a plurality of gates, one for each row. The outputs of the column-driving shift register and the row-synchronizing gates are applied directly to the pixels without interposition of further circuit elements.

Kalt and Babcock provides an effective drive system for electrostatic displays, especially displays employing relatively large pixels. One drawback of the system relates to high-resolution or small-pixel displays, e.g. computer or television monitors, where the numbers and density of pixels to be addressed raise potential difficulties in multiplexing the pixel array with an adequate refresh rate, and of possible cross-talk between pixels in adjacent rows or columns leading to unintended actuation of one or more pixels.

The cycle times of electrostatic pixels employing spiral rollout electrodes, of a size of interest for modern video displays, for a cycle including application and removal of an activation voltage, and mechanical rollout and retraction of a coiled electrode, are typically measured in milliseconds, while desired refresh rates are currently at least 30 Hz and for some applications 60 Hz or higher. Since even an EGA screen resolution of 640×480 pixels contains over 300,000 pixels, it is not practical to allocate a unique time slice to cycle each pixel individually and still achieve the desired refresh rate. The problem is compounded for higher resolutions such as VGA, super VGA and HDTV and for higher refresh rates.

In such higher resolution displays, where row and column conductors are close a switching signal intended for an adjacent or nearby pixel. It would be desirable to provide suitable drive circuitry which were resistant to cross-talk, even when the display has very small pixels, e.g 0.01 inches (about 250 microns) or less.

The electrostatic displays described above are suitable for a variety of applications, for example, desktop and notebook computer screens, television receivers, conference room or assembly hall presentation screens, instrumentation displays, sports stadium displays (including "scoreboards" with video presentations) and outdoor signage, e.g. highway condition informational signs, as well as smaller personal informational display devices or computer "appliances" such as personal digital assistants, game-playing devices, Internet-enabled cellular phones and so on. Such devices, as they have been known prior to the present invention, because of the limitations of their underlying pixel technology, employ more or less planar or, in the case of cathode ray tubes, mildly curved, fixed form display screens